Master Specification
Part RD-DK-D1

Road Drainage Design

September 2024

Government of South Australia
Department for Infrastructure and Transport

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Document Information

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Document Management

 This is a controlled document and it will be updated and reissued as approved changes are made.

Contents

RD-DK-D1 Road Drainage Design

1 General

a) This Master Specification Part defines the requirements for undertaking the design of stormwater systems associated with the Principal's road infrastructure, including:

i) the documentation requirements, as set out in section 2;

ii) the introductory requirements, as set out in section 3;

iii) the Safety in Design requirements, as set out in section 4;

iv) the environment requirements, as set out in section 5;

v) the drainage considerations, as set out in section 6;

vi) the operation and maintenance requirements, as set out in section 7;

vii) the hydrology requirements, as set out in section 8;

viii) the requirements for design inputs, as set out in section 9;

ix) the drainage, road surface, networks, basins and subsurface requirements, as set out in section 10;

x) the underground piped network requirements, as set out in section 11;

xi) the basin requirements, as set out in section 12;

xii) the subsurface drainage requirements, as set out in section 13;

xiii) the drainage open channels, culverts and floodway crossing requirements, as set out in section 14;

xiv) the culvert requirements, as set out in section 15;

xv) the floodway requirements, as set out in section 16;

xvi) the pump system requirements, as set out in section 17;

xvii) the stormwater discharge from external development site requirements, as set out in section 18; and

xviii) the Hold Point and Witness Point requirements, as set out in section 19.

b) This Master Specification Part has been developed to clarify or enhance the Austroads Guide to Road Design and Australian Rainfall and Runoff (ARR) and improve consistency of interpretation in South Australia, and:

i) AGRD Part 5 Drainage - General and Hydrology Considerations must be read as if modified in accordance with sections 3 to 9 of this Master Specification Part;

ii) AGRD Part 5A Drainage - Road Surface, Networks, Basins and Subsurface must be read as if modified in accordance with sections 10 to 13 of this Master Specification Part; and

iii) AGRD Part 5B Drainage - Open Channels, Culverts and Floodway Crossings must be read as if modified in accordance with sections 14 to 16 of this Master Specification Part.

c) Road drainage design must comply with the Reference Documents, including:

i) AGPT Part 10 Subsurface Drainage;

ii) AGRD Part 4 Intersections and Crossings: General;

iii) AGRD Part 5 Drainage - General and Hydrology Considerations;

iv) AGRD Part 5A Drainage - Road Surface, Networks, Basins and Subsurface;

v) AGRD Part 5B Drainage - Open Channels, Culverts and Floodway Crossings;

vi) AS 1289.3.8.1 Methods of testing soils for engineering purposes, Method 3.8.1: Soil classification tests - Dispersion - Determination of Emerson class number of a soil;

vii) AS 3735 Concrete structures for retaining liquids;

viii) Australian Rainfall and Runoff (ARR);

ix) Department Operational Instruction 20.1 - Care, Control and Management of Roads (Highways) by the Commissioner of Highways (Section 26 of the Highways Act);

x) Department Standard Drawings;

xi) Department for Environment and Water publication “Water Sensitive Urban Design Policy”;

xii) Engineers Australia, Guidelines for Responding to the Effects of Climate Change in Coastal and Ocean Engineering;

xiii) Guide to Climate Projections for Risk Assessment and Planning in South Australia;

xiv) WSA 05 Conduit Inspection Reporting Code of Australia;

xv) Services in Streets - a code for the placement of infrastructure services in new and existing streets; and

xvi) South Australian MUSIC Guidelines.

2 Documentation

2.1 Design Basis

In addition to the requirements of PC-EDM1 “Design Management”, the Design Basis must include:

a) the selected design standard for each relevant design element in accordance with the requirements of section 6; and

b) the selected representative concentration pathway (RCP), including justification for its selection.

2.2 Design Drawings

In addition to the requirements of PC-EDM1 “Design Management”, the Design Drawings must include information to support the hydrological assessment including catchment areas and contours, stormwater infrastructure, infrastructure layout, watercourse alignments and cross sections, and land use details.

2.3 Design Report

In addition to the requirements of PC-EDM1 “Design Management”, the Design Report must include:

a) a description of the existing stormwater system, existing flooding issues, asset ownership and condition of stormwater assets;

b) catchment plans and hydrologic modelling of the existing and proposed catchments, including descriptions of the hydrologic methods used in the analysis, results for various storm events and recommendation of flows to be adopted;

c) hydraulic modelling assumptions, methodology, and results;

d) schematic layouts of the hydrological model configuration including nodes, watercourses, conduits, and flow paths;

e) discussion on the proposed stormwater management strategy including measures proposed to mitigate adverse impacts on the receiving stormwater system and surrounding properties, including any culvert blockage assessment;

f) fauna and fish passage assessment, design criteria and details incorporated within the design;

g) copies of all Drainage Authority approvals in accordance with section 3.1.2a);

h) evidence of approval from the relevant council or Drainage Authority in relation to discharge, in accordance with section 3.2;

i) outcomes from the water quality risk assessment required by section 5.4;

j) details of the containment measures to be undertaken in the event of an accidental spill, in accordance with section 5.7.1c);

k) stormwater quality modelling assumptions, methodology and results including performance against water sensitive urban design targets specified in section 5.8.2;

l) where it can be demonstrated that no reasonable or practicable options exist to install infrastructure to meet the water quality improvement targets, a document detailing the reasons for not achieving water sensitive urban design targets in accordance with section 5.8.4f);

m) discussion on erosion control and proposed mitigation measures, including justification for the selection of the scour protection treatment in accordance with section 5.9.2e);

n) the Australian Rainfall and Runoff (ARR) blockage assessment form for each culvert crossing in accordance with section 5.10e);

o) a sketch outlining the stormwater asset ownership and maintenance responsibilities of all relevant Drainage Authorities, in accordance with section 7;

p) the flood immunity details required by section 8.3;

q) details on existing conditions or project constraints in accordance with section 8.4.5b)i);

r) the assessment of culvert performance under rare and very rare events (events, as agreed with the Principal) and requirements for floodway erosion control measures as required by section 15.4;

s) a register of stormwater models produced;

t) an assessment of each culvert's performance in flood resilience flows and the risk of damage to the roadway in accordance with section 15.4.2b); and,

u) details of the allowances made for climate change impacts in accordance with sections 5.2 to 5.11.

2.4 Design Documentation

In addition to the requirements of PC-EDM1 "Design Management", the Preliminary Design Documentation must include all relevant stormwater models prepared and used by the Contractor, including digital elevation models.

2.5 Quality Management Records

In addition to the requirements of PC-QA1 "Quality Management Requirements" or PC-QA2 "Quality Management Requirements for Major Projects" (as applicable), the Quality Management Records must include:

a) evidence of successful protocol compliance tests in accordance with the requirements of section 17.10;

b) as-constructed stormwater system details in shapefile format, provided in MGA coordinates suitable for use in ESRI ArcGIS and overlaid with aerial imagery and other state government data, including:

i) a “pits” shapefile detailing the location of all new stormwater pits, junction boxes and headwalls including attribute information that lists as a minimum:

A. pit type (for example, double side entry pit);

B. pit invert level (metres AHD);

C. design pit surface level (i.e. gutter invert for SEP, surface level for JB) (metres AHD); and

D. year of construction; and

ii) a “pipes” shapefile detailing the location of all new stormwater and modified stormwater pipes / culverts, including the following minimum attribute information:

A. pipe material and type;

B. pipe diameter, length and pipe class;

C. width / height (for reinforced concrete) (in millimetres);

D. upstream and downstream invert levels (metres AHD); and

E. year of construction.

2.6 O&M Manual

In addition to the requirements of PC-CN2 “Asset Handover”, the O&M Manual must include:

a) details of the proposed ongoing maintenance requirements to maintain the performance of the water quality treatment elements, as required by section 7.2b); and

b) details of all road drainage systems operations in accordance with the requirements of section 17.11.

3 Introduction (section 1 of AGRD Part 5)

3.1 Jurisdictional considerations (section 1.3 of AGRD Part 5)

3.1.1 General

a) Drainage Authorities within South Australia responsible for operation and maintenance of drainage infrastructure can include:

i) local council(s);

ii) the Department;

iii) other government departments or agencies; and

iv) private organisations.

b) Jurisdictional responsibilities for drainage infrastructure is clarified in Department Operational Instruction 20.1 - Care, Control and Management of Roads (Highways) by the Commissioner of Highways (Section 26 of the Highways Act).

3.1.2 Management and planning framework (Section 1.5 of AGRD Part 5)

a) Where road drainage design includes the proposed alteration to natural watercourses or any modifications to any of the existing constructed stormwater infrastructure under the responsibility of a Drainage Authority (including any constructed basins or wetlands), the Contractor must:

i) undertake the design in consultation with all relevant Drainage Authorities;

ii) obtain written Approval of any alterations to the council stormwater systems and any natural watercourses from all relevant Drainage Authorities; and

iii) provide copies of all Approvals to the Principal as part of the Design Documentation.

b) The Contractor must provide and document clarification on the stormwater asset ownership and maintenance responsibilities of each relevant Drainage Authority in accordance with section 7.1.

3.2 Approvals from relevant Drainage Authorities

Where the design involves discharge into any Drainage Authority controlled fixed capacity downstream stormwater infrastructure / watercourse, the relevant Drainage Authority must be consulted during the design process, and written Approval from the relevant Drainage Authority must be obtained and submitted to the Principal as part of the Design Documentation.

4 Safety in Design (section 2 of AGRD Part 5)

The Contractor must meet the Safety in Design requirements set out in PC-EDM2 “Safety Management in Design”.

5 Environment (section 3 of AGRD Part 5)

5.1 General (section 3.1 of AGRD Part 5)

The Contractor must comply with the following Reference Documents in relation to environmental management, stormwater quality and sustainability requirements:

a) Department Environment and Heritage Technical Manual Attachment 6A Protecting Waterways Guideline;

b) Department Environment and Heritage Technical Manual Attachment 6B Water Affecting Activities Best Practice Operating Procedure; and

c) Department Sustainability Manual.

5.2 Climate change (section 3.2 of AGRD Part 5)

5.2.1 Introduction and overview (section 3.2.1 of AGRD Part 5)

a) The approach to incorporate climate change in flood estimation must be based on the risk and consequence of failure of the asset, as detailed in chapter 5 of Australian Rainfall and Runoff (ARR) Book 1 - Scope and Philosophy.

b) The six-step process as detailed in chapter 6 of Australian Rainfall and Runoff (ARR) Book 1 - Scope and Philosophy must be undertaken to select the service life (i.e. future climate year) and future representative concentration pathway (RCP).

5.2.2 Climate projections in South Australia

a) The Department of Environment and Water (DEW) has developed the climate projections for use in South Australia in the Guide to Climate Projections for Risk Assessment and Planning in South Australia (SA Climate Change Guide).

b) Where the six-step process identifies that climate change should be considered, the increases in temperatures must be estimated in accordance with Guide to Climate Projections for Risk Assessment and Planning in South Australia.

c) Further information on the application of climate change projections to flood immunity of roadways and flood immunity of adjacent land uses is detailed in sections 8.3 and 8.4.

d) The average of the projected daily maximum and minimum temperatures changes for different design years must be in accordance with Table RD-DK-D1 5-1.

e) The 2070 (RCP 4.5) temperature increases are the average of the 2050 (RCP 4.5) and 2090 (RCP 4.5) temperature increases.

f) The estimation of increases in rainfall resulting from temperature increases must be in accordance with section 10.1.

Table RD-DK-D1 5-1 Increase in daily average temperature (°C) for seven natural resource management regions

Landscape region	2050 RCP 4.5	2050 RCP 8.5	2070 RCP 4.5	2070 RCP 8.5	2090 RCP4.5	2090 RCP8.5
Green Adelaide	1.4	1.6	1.6	2.5	1.9	3.4
Hills and Fleurieu	1.3	1.5	1.5	2.3	1.8	3.2
Eyre Peninsula	1.5	1.7	1.7	2.5	1.9	3.4
Kangaroo Island	1.3	1.4	1.5	2.2	1.7	3.0
Northern and Yorke	1.6	1.7	1.8	2.7	2.0	3.7
SA Arid Lands	1.7	2.0	2.0	3.1	2.3	4.3
Murraylands and Riverland	1.5	1.7	1.7	2.6	1.9	3.6
Limestone Coast	1.3	1.5	1.5	2.3	1.7	3.1
Alinitjara Wilurara	1.6	2.0	1.9	3.1	2.3	4.2

5.2.3 Changes in sea level (section 3.2.5 of AGRD Part 5)

a) The analysis of stormwater systems must incorporate future sea-level rise predictions within the Design Life of the stormwater infrastructure.

b) Future changes in the marine environment and sea levels must be in accordance with section 11 of Guide to Climate Projections for Risk Assessment and Planning in South Australia.

c) The future sea levels at 2090 (RCP4.5) medium confidence must be adopted at the location closest to the project site, unless agreed otherwise by the Principal. The Principal may request that future sea levels at 2090 (RCP8.5) are simulated and the results discussed with the Department's Stormwater Group before submission of the Preliminary Design Documentation.

5.3 Fauna passage / crossings (section 3.3 of AGRD Part 5)

a) Design of infrastructure that includes the alteration of natural watercourses must mitigate detrimental impacts to terrestrial and aquatic fauna passage.

b) Requirements for fauna and fish passage at culvert crossings must be determined in conjunction with the Principal's Environment and Stormwater Groups, prior to the commencement of Preliminary Design.

c) Refer to the Department's environmental standards and guidelines for more guidance, in particular the Protecting Waterways Guideline, Fauna Impact Assessment Guidelines, and the Best Practice Operating Procedure for Water Affecting Activities.

5.4 Water quality risk assessment

a) A water quality risk assessment must be completed and submitted to the Principal in accordance with Department Environment and Heritage Technical Manual Attachment 6A Protecting Waterways Guideline (available at https://www.dit.sa.gov.au/documents/manuals) prior to the commencement of the Preliminary Design.

b) The water quality risk assessment required by section 5.4a) must be commensurate with the project size and location.

c) A water quality risk assessment must consider the project as part of the larger catchment, the project's contribution to the water quality risk, existing water quality improvement infrastructure downstream, project constraints and maintenance responsibilities.

d) The water quality risk assessment must assess pollution reduction options as detailed in figure 3.12 'Flow chart for design of pollution treatment train' of AGRD Part 5 Drainage - General and Hydrology Considerations.

e) Road projects that are upstream of water harvesting infrastructure (for example, wetland systems with stormwater re-use) must consider potential changes in water quality (in accordance with section 3.7.7 of AGRD Part 5 Drainage - General and Hydrology Considerations to ensure there is no negative impact resulting from the project.

f) Projects or locations that may result in a medium to high risk must include the Principal's Environment and Stormwater Groups, local council, and landscape board in the risk assessment.

g) The acceptance of the water quality risk assessment outcomes will constitute a **Hold Point**. Detailed Design Documentation that is impacted the water quality risk assessment must not be submitted until this Hold Point has been released.

5.5 Water affecting activities permit

The Contractor must determine if the Works and Temporary Works constitute a water affecting activity under the Department Environment and Heritage Technical Manual Attachment 6B Water Affecting Activities Best Practice Operating Procedure, and require a permit under the *Landscape South Australia Act 2019* (SA) and in accordance with the Contract Documents.

5.6 Green Infrastructure Assessment

The design of WSUD infrastructure must respond to the Green Infrastructure objectives and desired characteristics defined in the Green Infrastructure Assessment (refer to PC-ST1 "Sustainability in Design") and Green Infrastructure concept plan (where provided).

5.7 Pollution control and water quality (section 3.4 of AGRD Part 5)

5.7.1 Spill management (section 3.4.3 of AGRD Part 5)

a) Where spill management infrastructure is deemed to be required (through the water quality risk assessment required by section 5.4), spill management must be provided in accordance with section 3.4.3 of AGRD Part 5 Drainage - General and Hydrology Considerations.

b) Where spill management is incorporated, 20 m^3 of accidental spill volume must be provided.

c) The Design Report must detail the measures to be undertaken in the event of an accidental spill to ensure spills are contained (for example, sand bagging of basins or swale outlets).

5.7.2 At-source vs catchment-based treatment for roads (section 3.4.5 of AGRD Part 5)

Consideration of at-source or catchment treatment approach, maintenance requirements and controls must be determined through the water quality risk assessment required by section 5.4 in conjunction with the relevant Drainage Authority responsible for maintenance of the treatment infrastructure.

5.8 Water sensitive design (section 3.5 of AGRD Part 5)

5.8.1 General

The Contractor must adopt a holistic approach to management of stormwater, particularly in large catchments, in accordance with the outcomes of the water quality risk assessment (section 5.4).

5.8.2 Performance objectives (section 3.5.4 of AGRD Part 5)

a) The Department for Environment and Water publication "Water Sensitive Urban Design Policy" details the Principal's water sensitive urban design objectives, principles and performance targets.

b) The Contractor must ensure that the Works achieve the performance targets specified in the Water Sensitive Urban Design Policy, including:

i) 80% reduction in average annual load of total suspended solids;

ii) 60% reduction in average annual load of total phosphorus;

iii) 45% reduction in average annual load of total nitrogen; and

iv) 90% reduction in average annual load of gross pollutants.

c) In addition to the targets specified in section 5.8.2b), the Contractor must ensure that the Works achieve the following targets:

i) retention of litter greater than 50 mm for flows up to the 4EY peak flow; and

ii) no visible oils / hydrocarbons for flows up to the 4EY peak flow.

d) Percent reductions in pollutants must be measured against 'base case' pollutant loads (i.e. modelled pollutant loads for the project without stormwater quality treatment measures).

5.8.3 MUSIC model (section 3.5.5 of AGRD Part 5)

a) The South Australian MUSIC Guidelines must be adopted for all MUSIC modelling, and provides information on various pollutant export relationships, treatment measures and how they should be modelled using MUSIC.

b) The Contractor must develop a MUSIC model when designing water sensitive urban design elements, in accordance with the requirements of the South Australian MUSIC Guidelines.

5.8.4 Selecting treatment elements (section 3.5.7 of AGRD Part 5)

a) The selection of water quality treatment elements must be in accordance with:

i) outcomes of the water quality risk assessment (section 5.4);

ii) figure 3.12 'Flow chart for design of pollution treatment train' of AGRD Part 5 Drainage - General and Hydrology Considerations;

iii) asset ownership and on-going maintenance requirements; and

iv) land acquisition constraints.

b) Treatment elements for rural roads must avoid regular on-going maintenance of water quality improvement infrastructure.

c) The selection of litter trap treatments must consider the project in relation to any downstream infrastructure that will assist in capture of gross pollutants in the network prior to discharge.

d) The Contractor must not install gross pollution traps for Department assets due to the resulting maintenance requirement.

e) The selection of gross pollution traps as a stand-alone project specific treatment element must be agreed with the relevant Drainage Authority responsible for its regular maintenance.

f) Where it can be demonstrated that no reasonable or practicable options exist to install infrastructure to meet the water quality improvement targets (for example, small projects or projects in urban brownfield environments) the reasons for not achieving water sensitive urban design targets must be included in the Design Report.

g) Acceptance of not achieving the water quality improvements targets (in-line with the water quality risk assessment outcome) will constitute a **Hold Point**. Detailed Design Documentation that is relevant for water quality improvement targets must not be submitted until this Hold Point has been released.

5.8.5 Bio-retention systems (section 3.5.8 of AGRD Part 5)

a) Consideration of bio-filtration systems is encouraged where there is adequate available land and does not negatively impact road safety or pavement design.

b) The selection and design of bio-filtration systems (as a treatment element) must be agreed with the relevant Drainage Authority responsible for its regular maintenance. Measures to capture sediment at inlets to the bio-filtration system, to facilitate easier maintenance, are to be provided.

5.8.6 Wetlands (section 3.5.9 of AGRD Part 5)

a) The adoption of wetlands is encouraged where there is adequate available land and maintenance regime is agreed with the relevant Drainage Authority.

b) The selection and design of wetlands (as a treatment element) must be agreed with the relevant Drainage Authority responsible for its regular maintenance.

c) Selection of appropriate plants are critical to the success of wetland systems, as wetlands are likely to be ephemeral they will need to survive both inundation and dry periods. The design of wetlands must be integrated with the landscape design packages.

5.8.7 Maintenance and disposal (section 3.5.11 of AGRD Part 5)

a) The regular maintenance of water sensitive urban design elements is key to the successful on-going operation and performance of the treatment device(s).

b) The on-going maintenance requirements of treatment devices must be agreed with the relevant Drainage Authority responsible for its regular maintenance in accordance with section 7.2.

5.9 Erosion and sediment (section 3.6 of AGRD Part 5)

5.9.1 General (section 3.6.1 of AGRD Part 5)

a) The soil characteristics at each individual site must be assessed by a geotechnical engineer to determine the site-specific risk and mitigation measures for erosion and sedimentation.

b) Sites with dispersive soils (soils having Emerson Class 1 or 2 in accordance with AS 1289.3.8.1 Methods of testing soils for engineering purposes, Method 3.8.1: Soil classification tests - Dispersion - Determination of Emerson class number of a soil, must incorporate additional erosion control measures to reduce the risk of erosion (for example a minimum of 150 mm of non-dispersive topsoil must be placed before revegetation to protect the cut face from erosion).

5.9.2 Scour (section 3.6.2 of AGRD Part 5)

a) Concentrated surface runoff must not be designed to discharge down any fill batter steeper than 1V:6H, unless contained within an enclosed conduit (pipe or box culvert) system. Where the batter is flatter than 1V:6H, an appropriately stabilised batter chute (open channel) may be used to transfer such flows down the batter.

b) Scour protection must be provided at any area susceptible to scouring, such as bridge piers and abutments, culvert inlets and outlets, longitudinal drain outlets, swales and channels and cross-sectional changes along constructed or natural watercourses where there may be a risk of erosion.

c) Scour protection must prevent scour for the design flow. Permanent scour protection measures must be provided in areas of concentrated flow (such as swales and channels) where the maximum allowable flow velocity of the in-situ soil type has been exceeded as defined in table 3.5 of AGRD Part 5 Drainage - General and Hydrology Considerations (or table 2.5 in AGRD Part 5B Drainage - Open Channels, Culverts and Floodway Crossings).

d) Techniques and treatments must be appropriately selected and designed to suit the application and performance requirements. The Principal's preferred treatment for scour protection in order of precedence on intervention is as follows:

   i) native grassed lined swales replicating the natural environment (as close as practical);

   ii) non-native grassed lined swales;

   iii) rock rip-rap lined channels; and

   iv) rock mattresses and gabions.

e) Where the selected treatment in section 5.9.2d) is lower in the Principal's order of precedence, the Design Documentation must demonstrate why other preferred treatments are not suitable in the relevant application.

f) The use of formal concrete channels, including concrete impregnated fabric or similar synthetic lining materials is subject to the approval of the Principal's Stormwater Group as a Design Departure.

5.9.3 Erosion and scour protection measures (section 3.6.4 of AGRD Part 5)

a) Batter protection measures utilising vegetation must consider the long-term ability to maintain sufficient vegetation coverage to prevent erosion of the batter.

b) Stormwater infrastructure must be used at the top of cut faces to prevent external water from flowing down and eroding the cut face.

c) Where a catch drain is used at the top of a cut face, to protect a cutting, underpass or lowered motorway, the effect of a rare event (1% AEP) must be considered, and stormwater infrastructure sized so that significant damage to the infrastructure is avoided in this event.

5.9.4 Rock protection (section 3.6.5 of AGRD Part 5)

a) Sizing of rock protection (rip-rap) must be completed prior to selection based on the formulae in section 3.6.5 of AGRD Part 5 Drainage - General and Hydrology Considerations.

b) Rock (rip-rap) lined channels must include an underlying geotextile fabric appropriate to the rock size with a minimum 100 mm freeboard to ensure design flows are restricted to the rock rip-rap lined area.

c) The maximum side slope for rock rip-rap lined channel is 1V:3H (the Principal may consider 1V:2H as a Design Departure) or as required for road safety purposes.

d) The use of loose rock for drainage infrastructure in urban and township locations, or adjacent to areas intended for future housing development, (where the rock may be used as a projectile and create a road safety risk) is to be considered as part of the Safety in Design process. Loose rock must not be used where it is deemed that there is a risk that the rock may be used to create a road safety risk.

5.9.5 Gabions and rock mattresses (sections 3.6.6 and 3.6.7 of AGRD Part 5)

a) Gabions and rock mattresses must be designed in accordance with the manufacturer's recommendations and are recommended as an alternative to 'hard' concrete structures.

b) The Contractor must assess the risk of vandalism at each location and where a high risk is identified, incorporate treatments to mitigate potential anti-social behaviour (for example, double mesh at exposed surfaces).

5.9.6 Ground cover (section 3.6.9 of AGRD Part 5)

a) Grassed linings must be designed having regard to the grass species to be used, the average annual rainfall, summer dry periods between rainfall events and the expected high flow duration in the swale / channel.

b) Table 2.6 of AGRD Part 5B Drainage - Open Channels, Culverts and Floodway Crossings may be used as a guide for determining if grass is a suitable treatment option once flow velocities have been determined.

c) All native grassed swales must be designed on the basis of a maximum cover of 50% and non-native grassed swales on the basis of a maximum cover of 70%. Ground cover must be self-sustaining and must not contain solely sterile species.

d) The Contractor's landscape designer must be consulted during the design phase to ensure that all scour protection objectives are achieved.

e) The maximum side slope for grassed channels is 1V:4H where not in the clear zone and where space permits.

5.9.7 Energy dissipators (section 3.6.10 of AGRD Part 5)

a) Energy dissipators (including drop structure) may be incorporated to reduce flow velocities and mitigate the risk of downstream scour.

b) The design of energy dissipators must minimise the requirement for regular on-going maintenance.

5.10 Blockage (section 3.7 of AGRD Part 5)

a) Blockage of multiple pipe and box culvert runs by floating debris, including branches and other vegetation or sediment is common in South Australia in rare flood events.

b) The design of culverts must provide infrastructure that reduces the risk of blockage from floating debris, which may include the following measures:

   i) single pipes, single span culverts, or single span wider structures should be used wherever practical;

   ii) the width and height dimensions of box culverts and diameter of pipe culverts are to be designed to minimise the risk of debris being caught on the upstream side of the culvert;

   iii) avoiding the use of small to medium size multi-cell pipe culverts; and

   iv) including debris deflector walls for multiple box culvert cells, where there is a medium to high risk of blockage.

c) The design of culverts must provide infrastructure that reduces the risk of sedimentation (or barrel blockage) which may include the following measures:

   i) variable invert levels at multi-cell culvert locations (the higher invert level may be integrated with fauna passage opportunities); and

   ii) sediment training walls.

d) An allowance for blockage of culverts must be determined by the Contractor in accordance with chapter 6 (blockage of hydraulic structures), Australian Rainfall and Runoff (ARR) A guide to flood estimation Book 6 Flood Hydraulics.

e) The Australian Rainfall and Runoff (ARR) blockage assessment form must be completed for each culvert crossing and included in an appendix of the Design Report, which must specify:

   i) the culvert ID and size of the culvert;

   ii) the critical value with respect to culvert blockage which must be the average length of the longest 10% of the debris reaching the site (L10); and

   iii) the L10 length (m), which must be determined from an inspection of debris on the floor of the source area, with due allowance for snagging and reduction in size during transportation to the structure.

f) Single box culverts or structures with a clear diagonal measurement greater than 6.0 m do not require assessment and allowance for blockage.

g) The consequences of partial or full blockage and potential damages to property and road infrastructure from a blockage must be assessed in a risk assessment.

h) In locations where the risk of culvert blockage is high, with the potential to inundate priority A or B floor levels (as defined in table 6.3 of AGRD Part 5 Drainage - General and Hydrology Considerations) or damage the roadway, where practical, a larger culvert or bridge crossing must be adopted.

i) The risk assessment and proposed approach to minimise the risk of culvert blockage and the proposed blockage factor must be assessed at the Concept Design, Reference Design or at the Preliminary Design Documentation submission stage of the project.

j) Submission of the blockage factors and approach to the Principal constitutes a **Witness Point**.

5.11 Tidal waters and storm surge (sections 3.8.2 and 3.8.3 of AGRD Part 5)

a) The SA Coast Protection Board can provide advice on the projected storm surge, wave set-up and run-up for a particular location.

b) Allowance for storm surge, wave set-up and wave run-up must be agreed with the Principal's Stormwater Group prior to the commencement of Preliminary Design.

c) The influence of tidal waters and storm surges on drainage design is detailed in section 8.

d) The influence of increasing sea levels from climate change is detailed in section 5.2.

6 Drainage considerations (section 4 of AGRD Part 5)

6.1 Selection of recurrence interval and flood immunity (section 4.4 of AGRD Part 5)

a) Noting the varying adjacent land uses, environments, and topography at different locations within the state and varying constraints for each project the design standard for a particular drainage element may be modified to manage the risk to the Department and adjacent community and land use.

b) The selected design event for different design elements must be specified and justified within the Design Basis, and the associated Hold Point set out in PC-EDM1 "Design Management" will apply.

6.2 Time of submergence / closure (section 4.5.3 of AGRD Part 5)

a) The time of submergence / closure is a measure of the disruption to traffic resulting from very large and extreme events. In rural catchments, the Principal may accept, lower flood immunity standard if the times of closure is low and the expected disruption is relatively minor.

b) In locations where the National Highway passes through a natural low point (for example, depression, salt pan or marsh area) the Contractor must assess the time of submergence of the roadway resulting from events that exceed the specified design flood immunity standard as detailed in Table RD-DK-D1-8-2.

c) Assessment of the time of submergence on National Highways will constitute a **Witness Point**. The relevant Detailed Design Documentation must not be submitted until the Contractor has proceeded past the Witness Point in accordance with PC-QA1 "Quality Management Requirements" or PC-QA2 "Quality Management Requirements for Major Projects" (as applicable).

d) Where the risk of submergence (and therefore road closure) exceeds a nominal 2 to 4 hours, the Contractor must advise the Principal and carry out further investigations.

6.3 Temporary Works

a) Temporary Works must be designed for a 0.5 EY storm event.

b) If there is a high likelihood of flood damage, then the level of service to be provided by the Temporary Works measure may need to increase and must be agreed with the Principal's Stormwater Group.

7 Operations and maintenance (section 5 of AGRD Part 5)

7.1 Asset ownership sketch

a) The Contractor must develop a sketch (at the concept and Preliminary Design stage) detailing stormwater asset ownership and maintenance responsibilities of each relevant Drainage

Authority (for example, local council, the Department, private organisations, or other government agencies), to inform discussions regarding asset ownership and maintenance. The sketch is to be finalised and included in the Design Report at the Final Design stage.

b) The sketch required by section 7.1a) detailing the stormwater asset ownership will constitute a **Witness Point**.

7.2 Water quality infrastructure maintenance

a) The on-going maintenance requirements of treatment devices must be agreed with the relevant Drainage Authority responsible for its regular maintenance.

b) The Contractor must submit its proposed ongoing maintenance requirements to maintain the performance of the water quality treatment elements, to the relevant Drainage Authority for approval during the Detailed Design phase, as part of the O&M Manual.

c) Erosion estimates must be completed to estimate regular maintenance requirements of any sediment basins in accordance with section 3.6.3 of AGRD Part 5 Drainage - General and Hydrology Considerations.

d) The Contractor must provide evidence of approval for the proposed ongoing maintenance requirements to the Principal, which will constitute a **Hold Point**. Final Design Documentation associated with the approval must not be submitted until this Hold Point has been released.

e) For the purposes of section 7.2a), where the Department is the local Drainage Authority the Contractor must obtain the approval of the Department's Asset Management Group.

7.3 Stormwater infrastructure condition assessment

a) Subject to section 7.3b) to 7.3e), existing stormwater infrastructure must not be retained as part of the Works.

b) If existing stormwater infrastructure is to be retained as part of the Works, a full condition assessment must be completed for the retained asset.

c) The condition assessment required by section 7.3b) must be undertaken in accordance with WSA 05 Conduit Inspection Reporting Code of Australia, and provide guidance on the asset's suitability, remaining residual Design Life and level of service to inform the decision making process.

d) Where the remaining residual Design Life of an existing stormwater infrastructure asset is less than 50% of its original Design Life (for example, 50 years residual life on concrete drainage structure) the Contractor must assess the resulting risk to retain the asset and the cost and benefit of replacing the infrastructure and submit this assessment to the Principal.

e) Acceptance of retaining existing stormwater infrastructure assets with less than 50% of residual Design Life will constitute a **Hold Point**. Final Design Documentation showing retention of existing stormwater infrastructure assets with less than 50% of residual Design Life must not be submitted until this Hold Point has been released.

8 Hydrology (section 6 of AGRD Part 5)

8.1 Probability terminology (section 6.2 of AGRD Part 5)

The Contractor must adopt the updated terminology in AGRD Part 5 Drainage - General and Hydrology Considerations, and Australian Rainfall and Runoff (ARR).

8.2 Catchment hydrology (section 6.3 of AGRD Part 5)

8.2.1 Catchment area

a) The catchment area must be calculated from topographic mapping or other survey or contour information.

b) The proportion of paved, supplementary paved and grassed area to be used for each land use may be determination by either:

i) the parameters shown in Table RD-DK-D1 8-1 for each land use type; or

ii) catchment impervious areas measured from aerial photographs and known potential future development in the catchment.

Table RD-DK-D1 8-1 Acceptable surface parameters

Land use	Paved %	Supplementary %	Grassed %
Commercial / industrial	90	0	10
Residential allotments <300 m^2	80	10	10
Residential allotments 300 - 500 m^2	70	10	20
Residential allotments 500 - 700 m^2	60	15	25
Residential allotments 700 - 1,000 m^2	40	15	45
Residential allotments 1,000 - 2,000 m^2	30	15	55
Rural allotments 2,000 - 4,000 m^2	10	10	85
Rural allotments >4,000 m^2	0	5	95

8.3 Flood immunity of roads and pedestrian, bicycle and shared paths (section 6.4.4 and 6.4.5 of AGRD Part 5)

8.3.1 Flood immunity of roads and paths

a) The design flood immunity of roads (risk of closure from flooding) must be in accordance with Table RD-DK-D1-8-2.

b) Diversion channels (side drains) that convey external flood flows parallel to the road alignment must be in accordance with Table RD-DK-D1-8-2.

c) Subject to the approval of the Principal, the flood immunity standard of individual infrastructure element of roads and paths as detailed with Table RD-DK-D1-8-2 may be reviewed in the following site-specific circumstances:

i) the road is a strategic link and events exceeding the defined flood immunity may result in a long road closure (nominally longer than 2-4 hours) without an easily available alternative route, (an increase to flood immunity standard);

ii) an existing constraint limits the flood immunity of an adjacent road segment (which will therefore limit the achievement of the flood immunity standard of the road link);

iii) a rural road with a low annual average daily traffic (AADT) where a high flood immunity may be difficult or expensive to achieve (a reduction to flood immunity standard); or

iv) where there is a readily available and convenient alternative route (a reduction to flood immunity standard).

d) Confirmation of the proposed flood immunity of roads and paths must be submitted to the Principal, which will constitute a **Hold Point.** The relevant Detailed Design Documentation must not be submitted until this Hold Point has been released.

8.3.2 Flood resilience of roads (refer to section 6.9 of AGRD Part 5)

a) Roads must be designed to be resilient to events greater than the specified design flood immunity to ensure:

i) the road is resilient to increased flows resulting from climate change; and

ii) uncertainties in flood estimation and the risk that actual flood flows are larger than the design flow modelled.

b) Road design must be resilient to ensure the road does not suffer total failure or damage (that limits re-opening) from events greater than the flood immunity including:

i) floodwater that overtops and flows over the road is managed (i.e. designed locations, flow rates and velocities);

ii) damage to the road is minimised and does not result in road failure (including washout, pavement undermining or severe erosion of channels or batters);

iii) time of submergence and closure time is minimised; and

iv) maintenance to enable re-opening after the event is minimised.

c) The Contractor must assess the impact of design events as detailed within Table RD-DK-D1-8-2 (including climate change) and incorporate infrastructure to manage flood flows over the roadway (i.e. manage velocities, erosion and scour).

Table RD-DK-D1-8-2 Flood immunity and resilience for roads and pathways

Component	Design standard (AEP or EY) for road category code and Austroads class				
	Rural local (class 4 and 5)	**Rural arterial (class 3)**	**Urban arterial and collector**	**National Hwy (class 1 and 2)**	**Motorways / expressways**
Flood resilience	2%	1%	1%	0.5%	0.5%
Flood immunity					
Cross drainage:					
Culverts (pipe or box)	10%	5%	5%	2%	1%
Bridges	5%	2%	1%	1%	1%
Floodway	10%	2%	N/A	N/A	N/A
Road surface drainage:					
General kerb and gutter with pit and pipe system	N/A	N/A	0.2EY	0.2EY	10%
Gutter flow and spread width	Refer to section 10.5 and section 5.4.2 of AGRD Part 5A Drainage - Road Surface, Networks, Basins and Subsurface				
Lowered roadways (below natural surface).	N/A	N/A	2%	1%	1%
Trapped flows (sags):					
Where the escape path could inundate a building	Refer to table 6.3 of AGRD Part 5 Drainage - General and Hydrology Considerations				
Other	N/A	N/A	10%	10%	10%
Longitudinal drainage:					
Longitudinal open drains (swales, table drains and catch drains)	0.2EY	10%	10%	10%	10%
Diversion channels	10%	5%	5%	2%	1%
Pathways and roadway verges:					
Shared paths			1EY		
Pedestrian or shared path underpasses			5%		
Other:					
Water sensitive urban design			4EY		

8.4 Flood immunity of adjacent land use

8.4.1 Introduction

a) The Contractor must undertake an assessment of overland flow paths and the flood immunity of adjacent land use to ensure the project achieves the flood immunity standard in accordance with the adjacent land use priority, as detailed in table 6.3 of AGRD Part 5 Drainage - General and Hydrology Considerations.

b) Assessment of the flood immunity standard of adjacent land use must as a minimum include the scenarios detailed in Table RD-DK-D1 8-3.

Table RD-DK-D1 8-3 Flood immunity of adjacent land scenarios

Scenario	Infrastructure	Catchment	Rainfall
Existing	Existing	Existing	Current design rainfall
Project case (day of opening)	Proposed	Existing	Current design rainfall
Future project case	Proposed	Existing	Future design rainfall (including climate change)
Future project and catchment case	Proposed	future catchment	Future design rainfall (including climate change)

8.4.2 Future design rainfall (incorporating climate change)

a) The future design rainfall incorporating the projected future changes to rainfall patterns (resulting from climate change) must be assessed in accordance with section 5.2.

b) The assessment of the future climate change scenario must be based on the six-step process as detailed in chapter 6 of Australian Rainfall and Runoff (ARR) Book 1 - Scope and Philosophy.

c) Guidance of the ARR risk category when compared to the infrastructure scenario (as detailed in table 6.3 of AGRD Part 5 Drainage - General and Hydrology Considerations) is provided in Table RD-DK-D1 8-4.

d) The future design year to be adopted for the climate change RCP scenario must be based on the Design Life of new infrastructure or residual (remaining) life of the existing infrastructure and:

i) 2090 for new cross drainage infrastructure with a Design Life of 100 years or greater;

ii) 2070 for existing infrastructure with a residual (operational) life of 51 to 99 years; or

iii) 2050 for existing element with a residual (operational) life of 50 years or less.

Table RD-DK-D1 8-4 ARR risk category and infrastructure priority

ARR risk category	Priority	Situation (refer to table 6.3 of AGRD Part 4 Intersections and Crossings: General)	Climate change scenario
High	A	Hospitals, emergency services stations, water and wastewater centres, substations, convalescent homes emergency facilities etc.	RCP 8.5
Medium	B	Residences, food and retail stores, centres of large employment, community administration and education centres etc.	RCP 4.5
Low	C	Grounds of priority A and B buildings (excluding access and egress routes) and other open spaces, farmland etc.	As agreed with the Department

8.4.3 Future changes in catchment conditions

a) The Contractor must adopt the outcome of planned changes to catchments from an approved stormwater management plan (typically in urban areas), including:

i) hydrologic and hydraulic modelling and or flood mapping study; and

ii) to future land use (and changes to impervious areas).

b) In locations where development is planned within a 30-year future timeframe, and no current approved stormwater management plan exists, the Contractor must estimate:

i) the future catchment based on the future allowable development (including increased density) detailed in relevant council or planning and land use approved land development plans; and

ii) adopt parameters as agreed with the Principal.

8.4.4 Flood modelling afflux

a) Flood level increases more than 20 mm must be mitigated for priority A and B situations as defined in table 6.3 of AGRD Part 5 Drainage - General and Hydrology Considerations, unless otherwise agreed with the Principal.

b) For the avoidance of doubt, differences of ±20 mm between existing and proposed flood levels may be shown as no change in the afflux maps.

c) Flood afflux mapping for the flood immunity standard of adjacent land use (section 8.4.5) is to be compared to the existing scenario, as detailed in Table RD-DK-D1 8-3.

8.4.5 Flood immunity standard of adjacent land use

a) The Contractor must achieve the flood immunity standard of adjacent land use as detailed within the Contract Documents. Where the flood immunity standard is not defined in the contact document the following scenarios, as detailed in Table RD-DK-D1 8-3 apply:

i) minimum - the project case (day of opening); and

ii) desirable - future project and catchment case.

b) In locations where existing conditions or project constraints limit achieving desirable flood immunity standards for adjacent land use the Contractor must:

i) provide the details on existing conditions or project constraints within the Design Report;

ii) the flood immunity standards achieved within the project constraints;

iii) methods to mitigate the risk of damage; and

iv) nominal addition works to achieve the flood immunity standard.

c) Confirmation of the proposed flood immunity of adjacent land use, must be submitted to the Principal, which will constitute a **Hold Point.** Relevant Final Design Documentation must not be submitted until this Hold Point is released.

8.5 Urban hydrology

a) The Contractor must develop a DRAINS model for road stormwater designs in urban areas. The ILSAX or initial loss - continuing loss hydrology options must be used.

b) Where the Contractor uses the default antecedent moisture conditions (AMC) and Horton soil type:

i) the US Natural Resources Conservation Service infiltration curves must be used in DRAINS;

ii) soil type 4 must be used for most clay soils in Adelaide; and

iii) where justified by the soil type (for example, sandy soils near the coast) lower soil type figures may be used.

c) Following an analysis of urban streamflow gauging records, the pervious area initial loss was found to be at least 45 mm in Adelaide with a continuing loss of 3 mm/h. These values may be entered under the ‘you specify’ section under soil type.

d) Depressed storage (losses) must be adopted as follows:

i) pre-development (i.e. green fields) values - 1 mm paved, 1 mm supplementary and 10 mm grassed; and

ii) post-development values - 1 mm paved, 1 mm supplementary and 5 mm grassed.

e) The Contractor must perform an analysis of antecedent moisture conditions (AMC) with a nominal value of 2.5 generally adopted. Alternatively, rainfall data (available from the Bureau of Meteorology) can be used to determine a location specific antecedent moisture conditions (AMC) parameter.

f) As urban runoff in South Australia is dominated by the impervious area response a simple initial continuing loss model may also be used for the grassed (pervious) area.

g) A minimum of 150 mm freeboard is required between design water levels and gutter inverts at all kerb inlet pits.

8.6 Rural hydrology

8.6.1 General

a) For rural catchments less than 5 km^2 the Department Rational Method as outlined in section 8.8 may be adopted and reviewed against at least one other method to estimate peak flows.

b) For catchments larger than 5 km^2 the proposed hydrological approach must include 3 or more methods to estimate the flow derived.

c) The Contractor must recommend a flow from the various methods based on the different approaches. Submission and acceptance of the recommended flows to the Principal's Stormwater Group will constitute a **Hold Point**.

d) The relevant Detailed Design Documentation must not be submitted until the Contractor has proceeded past the Hold Point in accordance with PC-QA1 "Quality Management Requirements" or PC-QA2 "Quality Management Requirements for Major Projects" (as applicable).

8.6.2 Existing flood / drainage studies

a) Stormwater management plans and many older flood / drainage studies have been undertaken over many parts of the state and can be a valuable source for estimating flood flows.

b) Where a road project is within the area of an existing flood / drainage study the Contractor must review the existing study and adopt the methodology to determine the flow, where appropriate.

8.6.3 Measured flow data

Where measured flow data is available in the same hydrological catchment (or in a hydrologically similar adjacent catchment), this data must be used for hydrological model calibration and flood frequency analysis and the results considered as part of the design flow selection process.

8.6.4 Hydrology in SA arid regions

a) The Principal notes the ephemeral nature of flows in the arid and semi-arid regions within South Australia and limited data on stream flow and research on the appropriate regional regressions to be adopted for different catchments.

b) The Contractor must review available research and relevant papers on best current practice to determine hydrological flows in arid and semi-arid regions including review of similar hydrological conditions and catchments in adjacent states and territories.

c) The Contractor must submit its proposed approach to hydrological estimates in arid and semi-arid regions to the Principal, which will constitute a **Witness Point**. The relevant Detailed Design Documentation must not be submitted until the Contractor has proceeded past the Witness Point in accordance with PC-QA1 "Quality Management Requirements" or PC-QA2 "Quality Management Requirements for Major Projects" (as applicable).

8.6.5 South Australian hydrology references

Stormwater and hydrology assessments may use the following South Australian specific Reference Documents for guidance:

a) Predicting Storm Runoff in Adelaide - How much do we know (Paper by Kemp DJ & Lipp WR in seminar proceedings, Living with Water, Hydrological Society of SA);

b) An Investigation into the Efficacy of Australian Rainfall and Runoff 2016 Procedures in the Mount Lofty Ranges, South Australia, Kemp and Hewa; and

c) A Regional Flood Frequency Analysis for the Northern Flinders Ranges (Kemp et al 1989).

8.7 Recommended methods comparison (section 6.6.4 of AGRD Part 5)

8.7.1 General

The following hydrological models may be suitable for use in determining rural hydrology:

a) DRAINS Initial Loss - Continuing Loss (IL-CL) (Australian Rainfall and Runoff (ARR) preferred model) and Horton ILSAX hydrological models;

b) RORB - Stormwater Runoff Routing Software (Monash University);

c) WBNM - Watershed Bounded Network Model;

d) XP-RAFTS - Hydrological Analysis Software (Innovyze);

e) FLIKE - Flood Frequency Analysis Software (TUFLOW);

f) The Department Rational Method (as detailed in section 8.8); and

g) Regional Flood Frequency Estimation Model (RFFE Tool).

8.7.2 RORB

a) RORB models for catchments within or in close proximity to the Mount Lofty ranges must use the methodology as recommended in the Uni SA paper An Investigation into the Efficacy of Australian Rainfall and Runoff 2016 Procedures in the Mount Lofty Ranges, South Australia, Kemp and Hewa.

b) RORB models for catchments outside the Mount Lofty ranges must use the methodology as detailed in Australian Rainfall and Runoff (ARR).

8.7.3 Regional Flood Frequency Estimation Model (RFFE tool)

a) Australian Rainfall and Runoff (ARR) has developed an online regional regression tool to estimate flows from rural catchments, known as the Regional Flood Frequency Estimation Model.

b) The Department's review of the estimated flows from the RFFE model 2016 V1 tool in South Australian locations has identified the estimated flows may have a large variance compared to other methods, particularly for rare and very rare events.

c) The RFFE tool may be used as a resource to assess against other methods. RFFE model 2021 V2 is a significant revamp of the previous version (2016 V1), however version 2021 V2 may be over estimating peak flows compared to other methods.

d) When the RFFE tool is used, the shape of the catchment, slope, soil type and depth, the average rainfall and vegetation type and cover must be considered in estimating design flood flows.

8.8 Department Rational Method

8.8.1 General

a) The Department Rational Method is based on the rational method formula as shown in section 6.6.3 of AGRD Part 5 Drainage - General and Hydrology Considerations and was developed for small rural catchments less than 5 km^2.

b) The Department Rational Method estimate must be compared to at least one other method (such as regional regression formulas or hydrological model results) and then engineering judgement used in selecting a design flow.

c) For rural catchments with a defined watercourse, the Bransby-Williams formula as defined in section D.2.2 Time of Concentration of AGRD Part 5 Drainage - General and Hydrology Considerations must be used.

8.8.2 Runoff coefficient, C

a) Step 1 - Select a base coefficient (10% AEP level) in accordance with Table RD-DK-D1-8-5.

Table RD-DK-D1-8-5 Catchment terrain base coefficients

Type of catchment terrain	Base coefficient
Native semi-arid grassland	0.25
Dairy farming, orchards / vineyards, horticulture	0.20
Cereal cropping, mixed farming	0.15
Natural scrub, forest plantations	0.10

b) Step 2 - Select a slope adjustment in accordance with Table RD-DK-D1-8-6 and add / subtract to base coefficient in step 1.

Table RD-DK-D1-8-6 Adjustment factors

Se (equal area slope) as used in the Bransby-Williams formula	Adjustment factor
Se < 2 m/km	-0.08
2 m/km ≤ Se < 5 m/km	-0.05
5 m/km ≤ Se < 50 m/km	0.0
Se > 50 m/km	+0.03

c) Step 3 - Catchment area adjustment:

i) multiply result of step 2 by: $\left(\frac{100}{A}\right)^{0.1}$ (A = catchment area in km^2); and

ii) if the adjusted C after step 3 >0.4 use 0.4.

d) Step 4 - Location adjustment:

Multiply result of step 3 by the factor read from the map in Appendix 1: Location adjustment factor (step 4 of Department Rational Method).

e) Step 5 - AEP or EY adjustment factor in accordance with Table RD-DK-D1-8-7 multiplied by the result of step 4.

Table RD-DK-D1-8-7 AEP and EY factors

AEP or EY	Factor (to multiply result of step 4 by)
0.2EY	0.7
10%	1.0
5%	1.15
2%	1.4
1%	1.6

9 Design inputs (section 6.7 of AGRD Part 5)

9.1 Design rainfall (section 6.7.3 of AGRD Part 5)

a) The rainfall intensity derived must be derived from Australian Rainfall and Runoff (ARR) intensity-frequency-duration (IFD) design rainfalls for the geographic location at the nominal centroid of the catchment.

b) The projected changes in temperature from climate change is detailed in section 5.2.

9.2 Joint probability considerations in road flood design (section 6.12.3 of AGRD Part 5)

a) The design of stormwater infrastructure potentially impacted by sea levels must ensure the influence of storm surge at the high astronomical tide (HAT) including sea level rise allowance, does not result in flooding of adjacent properties (i.e. backflow up the stormwater system) and inundation of Department or private infrastructure.

b) Projected sea level rise is to be determined in accordance with section 5.2.

c) A scenario that includes projected sea level rise, storm surge, mean high water spring tide level and a 0.2EY storm event in the contributing catchment is also to be simulated and compared to the 3 cases in section 6.12.3 of AGRD Part 5 Drainage - General and Hydrology Considerations, Coast stream affected by tidal levels, dot point 5.

10 Drainage - road surface, networks, basins and subsurface (AGRD Part 5A)

10.1 Minor system (section 2.2 of AGRD Part 5A)

a) The Contractor must design the minor system to convey surface run-off away from the pavement to enable continued operation of the roadway in the specified design event as detailed in Table RD-DK-D1-8-2.

b) The design assessment of minor storm events must, as a minimum, include:

i) existing infrastructure with current rainfall intensities; and

ii) design infrastructure with current rainfall intensities.

c) The Principal notes the future changes to rainfall patterns (resulting from climate change) will increase the frequency that the capacity of the minor system is exceeded.

10.2 Major system and regional approach (sections 2.3 and 2.4 of AGRD Part 5A)

The Contractor must design the major system to mitigate the flooding to adjacent land in accordance with section 8.4.

10.3 Major urban drainage design concepts (sections 2.6.2 of AGRD Part 5A)

Department road drainage design is to consider major storm flow discharges from adjacent existing or future development. The major flow discharge or stormwater detention requirements are to be confirmed with the Drainage Authority. The cross drainage at the expected point of discharge from existing or future development will need to be sized to accommodate major flows from the existing or future development.

10.4 Aquaplaning (section 4 of AGRD Part 5A)

10.4.1 General

a) An aquaplaning assessment must be completed as part of the road design process at the Detailed Design phase and endorsed by the Contractor prior to the Final Design stage.

b) Evidence of this assessment must be provided at critical locations where the water film depth is anticipated to be close to, or exceeds, the assessment.

10.4.2 Assessment criteria (section 4.10.1 of AGRD Part 5A)

a) The assessment criteria for maximum film depth that applies is:

   i) 3.25 mm (desirable) 4.0 mm (absolute) must apply to:

      A. roads with a posted speed limit of 80 kph or higher; and

      B. signalised intersections and roundabouts, including 50m approaches and departures; and

   ii) 5.0 mm must apply to all other situations.

b) All concentrated flows across the road pavement (for example, at median breaks, kerb terminations and cross fall transitions) must limit the flow to be less than 5 L/s for a 1 EY 5-minute duration storm intensity.

c) In the event there is no reasonable or practical alternative to manage film depth a Design Departure must be raised for approval by the Principal's Road Design Group.

10.4.3 Texture depth (section 4.9.3 of AGRD Part 5A)

The texture depth for flexible pavements must be assessed for the nominated surfacing type as follows:

a) for asphalt surfacing the "unacceptable low" texture depth as detailed in RD-BP-D4 "Surface Characteristics of Flexible Pavements" (i.e. OG14=0.9 mm, SMA10=0.6 mm, AC10 dense mix=0.3 mm); and

b) for spray seal surfacing the lower bound texture of 'work to be rectified' in RD-BP-D2 "Design and Application of Sprayed Bituminous Surfacing" (i.e. for 14/7-16/7-14/5-10 mm seals = 1.3 mm).

10.5 Kerbed drainage (section 5 of AGRD Part 5A)

10.5.1 General

The Contractor must utilise complete hydraulic calculations for kerbed drainage in accordance with section 8.5).

10.5.2 Kerbing (section 5.3.1 of AGRD Part 5A)

a) Department standard kerbing must be used as detailed on the Department Standard Drawings.

b) Kerb openings may be adopted as part of water sensitive urban design infrastructure in locations where the posted speed limit is 70 km/h or less. Kerb openings must:

   i) be a minimum of 300 mm in width with a minimum 30 mm set down from the gutter level to the outlet (to reduce risk of sediment blockage);

   ii) spaced evenly along the kerb line (to reduce concentration of flow); and

   iii) incorporate a minimum 45° longitudinal taper from the opening to the standard kerb profile.

10.5.3 Inlets (section 5.3.2 of AGRD Part 5A)

a) Standard stormwater inlets must be used as detailed on the Department Standard Drawings.

b) Double side entry pits must be used unless approved otherwise by the Principal's Stormwater Group as a Design Departure (due to a local constraint).

c) Double side entry pit must incorporate deflector vanes where the longitudinal road grade is 2% or more. The requirement must be included in the 'comments' column of the drain connection details schedule and the general construction drawings.

d) Where there is no practical alternative to install a Department standard inlet, subject to approval from the Principal's Stormwater Group:

   i) alternative side entry inlet structures may be used (in conjunction with a Department standard pit base) in locations where the standard inlet is too wide (e.g. in narrow medians or constrained locations); and

   ii) combination side entry inlet and grated inlets may be used in locations where required due to underground constraints.

e) Grated gully inlets (without a side entry inlet) or continuous capture inlets (e.g., grated trench drain) must not be used for roadway drainage inlets unless approved as a Design Departure by the Principal.

10.5.4 Inlet locations (section 5.3.4 of AGRD Part 5A)

a) The Contractor must provide inlet redundancy for (trapped) sag inlets at locations:

   i) where the escape path could potentially inundate priority A or B floor levels (as defined in table 6.3 of AGRD Part 5 Drainage - General and Hydrology Considerations);

   ii) where the blockage of the sag pit could result in a water hazard deeper than 50 mm within the road traffic lanes; or

   iii) where the gutter flow widths exceed the allowable spread widths in Table RD-DK-D1-10-1.

b) Sag pit inlet redundancy, where required, must include extra stormwater inlets up to 10 m either side of the sag pit with gutter levels 50 mm higher than the sag point level.

c) Side entry pits must not be located within 1 m of a driveway or the tangent point of an intersection.

d) Class C inlet cover and support must be provided where there is a high likelihood of the pit cover being damaged by a vehicle, which must be identified in the comments section of the drainage schedule.

10.6 Pavement spread and gutter flow limits (section 5.4.2 of AGRD Part 5A)

a) The design requirements to be applied to the Department's, roads to manage gutter flow widths, are shown in Table RD-DK-D1-10-1.

b) The minimum practical spacing of inlet pits to achieve the requirements specified in Table RD-DK-D1-10-1 on Department roads is 30 m.

c) In locations with flat grades where the gutter flow width requirements cannot be achieved with the minimum practical spacing of inlet pits, the Contractor must consult with the Principal's Stormwater Group to review gutter flow requirements.

Table RD-DK-D1-10-1 Allowable spread widths and gutter flows

Element	Design requirement
Freeways (motorways / expressways)	Flow widths must not extend into traffic lanes in a 0.2 EY event; and minimum of one lane in each direction free of gutter flows in a 1% AEP event.
Arterial roads ≤60 km/h posted limit	Flow width of 1.5 m (max) extending into lanes in a 0.2 EY event.
Arterial roads >60 km/h posted limit	Flow width of 1.25 m (max) extending into lanes in a 0.2 EY event.
Collector roads	One lane each way free of gutter flows in a 0.2 EY event.
Local roads	As agreed with the relevant council, or one lane width (3.5 m) free of gutter flows in a 0.2 EY event.
Pedestrians	Maximum gutter flow width of 0.5 m upstream of a pedestrian crossing in a 1 EY event.
Cyclists	Maximum gutter flow width of 50% of the bicycle lane width in a 2 EY event.
On-street parking	Maximum gutter flow width of 2.0 m in a 1 EY event.

10.7 Inlet capture rates (section 5.5.2 of AGRD Part 5A)

a) The full-sized University of SA test rig inlet capture test results (both on-grade and sag) must be used for the Department standard side entry pit and grated inlet pit for concrete side drains.

b) For alternative types of side entry or combination inlets (approved for use by the Principal in accordance with section 10.5.3) test results from other state road authorities may be adopted.

10.8 Blockage (section 5.5.3 of AGRD Part 5A)

Blockage factors (as detailed in table 5.4 in AGRD Part 5A Drainage - Road Surface, Networks, Basins and Subsurface) must be applied to the minor design event, in addition to the application in the major event.

11 Underground piped networks (section 6 of AGRD Part 5A)

11.1 General

The Principal requires the completion of a DRAINS model or 12D drainage analysis model to undertake the required hydraulic calculations for underground stormwater infrastructure in Department roads.

11.2 Design considerations (section 6.2 of AGRD Part 5A)

11.2.1 Capacity of existing systems (section 6.2.2 of AGRD Part 5A)

Capacity of the existing system must be agreed with the relevant Drainage Authority.

11.2.2 Access chamber location (section 6.2.3 of AGRD Part 5A)

a) The Principal requires a maximum pit spacing (side entry pit or junction box) for maintenance access, of 100 m (in general) or 200 m for outlet pipes greater than 1,800 mm in diameter.

b) Access chamber lids are to be located outside of wheel paths of traffic lanes and at locations to minimise traffic disruption during maintenance access.

11.2.3 Existing drainage infrastructure (section 6.2.4 of AGRD Part 5A)

a) The location of existing drainage infrastructure is to be confirmed by service proving or site survey.

b) The Contractor must review the location of existing drainage infrastructure and confirm the existing infrastructure does not clash with new infrastructure and has suitable cover to the finished surface (including cover to construction loading and pavement construction).

11.2.4 Location of other infrastructure (section 6.2.5 of AGRD Part 5A)

Longitudinal stormwater drains must be located as detailed in the South Australian Public Utilities Advisory Coordinating Committee (PUACC) publication Services in Streets - a code for the placement of infrastructure services in new and existing streets, unless approved otherwise as a Design Departure due to an existing constraint.

11.2.5 Access chambers (section 6.3.1 of AGRD Part 5A)

a) Splayed pipe or box culverts must be provided for connections to angles of less than 90°, between the inlet or outlet pipes at any pit (i.e. side entry pit, junction box or access pit).

b) Step irons and access ladders are not provided in Departmental pits.

11.3 Materials (section 6.3.3 of AGRD Part 5A)

a) Pits and inlets must be in accordance with the Department Standard Drawings unless approved otherwise by the Principal as a Design Departure.

b) Culverts must comply with the following:

   i) box culverts must be reinforced concrete (RCBC);

   ii) pipe culverts must be either:

      A. reinforced concrete (RCP);

      B. fibre cement (FRC); or

      C. twin-wall ribbed polypropylene (TWRPP) stormwater pipes, where approved by the Department;

   iii) rubber ring jointed pipes must be used unless approved otherwise by the Principal as a Design Departure;

   iv) metal culverts must not be used for stormwater purposes; and

   v) recycled plastic pipes may only be used in non-trafficable areas.

c) The Principal supports the adoption of alternative materials that have reduced carbon emissions in production, where the achievement of the structural requirements and Design Life can be demonstrated as part of a Design Departure.

11.4 Structural requirements (section 6.4 of AGRD Part 5A)

11.4.1 General

a) Underground piped networks (including pits, pipes, and culverts) must have a minimum structural Design Life of 100 years, unless agreed otherwise by the Principal's Structures Group as a Design Departure.

b) Structural design of box culverts and non-standard pits must be in accordance with ST-SD-D1 "Design of Structures" and RD-DK-S1 "Supply of Pipes and Culverts".

c) Selection of pipe class / culvert loading must address loading from construction activities in accordance with RD-DK-S1 "Supply of Pipes and Culverts".

d) Prior to the use of jacking pipes, the Contractor must gain approval from the Principal's Structures Group.

e) Where there is insufficient cover under the road to achieve the depths for pipes (as detailed in table 6.1 of AGRD Part 5A Drainage - Road Surface, Networks, Basins and Subsurface), box culverts must be used.

11.4.2 Bedding and haunch support (section 6.4.3 of AGRD Part 5A)

HS2 bedding and haunch support must be provided in construction.

11.5 Design criteria (section 6.5 of AGRD Part 5A)

11.5.1 General

a) A 20 mm difference in level is required between all inlet pipes and the outlet pipe from a junction box. This level difference may be reduced in flat locations with a pipe grade less than 0.5%.

b) Underground drainage line runs must have a constant direction and grade between pits, unless approved otherwise by the Principal's Stormwater Group as a Design Departure.

c) "Wet" systems (syphons) are not permitted.

d) At landlocked sag points where flooding could be potentially hazardous, a second outlet pipe must also be provided to a separate outfall, where practical.

11.5.2 Size (section 6.5.2 of AGRD Part 5A)

To reduce the risk of blockage, minimum culvert sizes must be in accordance with Table RD-DK-D1-11-1.

Table RD-DK-D1-11-1 Minimum culvert size

Culvert type	Downstream of a pit	Downstream of a headwall
Pipe	375 mm	450 mm
Box culvert	375w × 300h mm	450w × 300h mm

11.6 Clearances (section 6.5.5 of AGRD Part 5A)

Where stormwater drainage infrastructure must be located within close proximity to existing services, the relevant Utility Service Authority guidelines must be used to determine required horizontal and vertical clearances.

11.7 Pit losses (section 6.6.8 of AGRD Part 5A)

The Queensland Urban Drainage Manual (QUDM) may also be used to calculate pit losses. DRAINS software allows users to calculate pit losses using Queensland Urban Drainage Manual charts.

12 Basins (section 7 of AGRD Part 5A)

12.1 Basin construction (section 7.1.4 of AGRD Part 5A)

a) Basins must use natural features to enhance local aesthetics where practical.

b) Basins must be designed to mitigate the risk of creating an insect nuisance (for example, mosquitoes) to adjacent properties and community facilities. Monitoring of mosquitos prior to construction and following construction of any basin (that holds water) for a time frame approved by the Principal is required where mosquitos may be a public nuisance.

c) Basins must include impervious lining in the following situations:

   i) where identified within the water quality risk assessment;

   ii) in expansive soils with a resulting risk of negatively impacting adjacent infrastructure;

   iii) locations that may negatively impact with underground services; and

   iv) locations with known existing contamination, where an unlined basin may increase the risk of dispersing the contamination.

d) Where the lined basin will accumulate sediment, a minimum 150 mm rock protection lining to delineate the basin design invert (and protect the liner), must be provided.

12.2 Detention basins (section 7.2 of AGRD Part 5A)

a) Detention basins must be provided where:

   i) the existing downstream system has limited capacity to accept the increase in flow from the Project; or

   ii) there is available land within the project extents to provide a basin (it is noted property constraints may limit the ability in smaller inner urban projects).

b) In locations where not providing a detention basin(s) is demonstrated to be advantageous to the stormwater system and provides a better outcome, no basin is required.

c) Where a detention basin is provided the basin must be sized to the greater of:

   i) the relevant Drainage Authority's requirements as agreed with the Principal's Stormwater Group; or

   ii) the nominal design requirement, which is no increase in the 0.2 EY peak flow and no increase in flood risk for the 1% AEP peak flow, compared to existing conditions.

d) All detention basins must be sized using a runoff routing model such as DRAINS or 12D drainage analysis model. The basin must be assessed for multiple storm durations for the design AEP to ensure the critical storm volume is detained.

e) "Wet" detention basins that permanently retain water must not be used. Extended detention in wetlands to achieve water quality targets is encouraged.

f) Low flow swales through detention basins are encouraged to facilitate maintenance of the basin (e.g. when a minimum bed gradient of 2% or greater to promote efficient basin drainage is not feasible).

12.3 Other design considerations (section 7.2.9 of AGRD Part 5A)

a) Where the basin includes a bank above natural surface, provision must be made for safe overflow by a formalised spillway to ensure that the banks do not scour.

b) Maintenance requirements for basins must be considered and detailed including the following:

   i) all weather access to the basin (from the nearest public road) for maintenance vehicles including room for a vacuum truck to park within 10 m of inlet and outlets;

   ii) access to the invert for a maintenance vehicle appropriate to the size and layout of the basin (for example, front end loader or excavator) for future maintenance; and

   iii) access ramps must be provided with a 1V:10H or flatter gradient.

13 Subsurface drainage (section 8 of AGRD Part 5A)

a) The requirement for subsurface drainage to manage groundwater influence on pavements and geotechnical conditions must be in accordance with the pavement and geotechnical requirements of the relevant Master Specification.

b) Where subsurface drainage is proposed the design must be completed in accordance with both AGRD Part 5A Drainage - Road Surface, Networks, Basins and Subsurface, and AGPT Part 10 Subsurface Drainage.

14 Drainage - Open channels, culverts and floodway crossings (AGRD Part 5B)

14.1 General considerations (section 2.2 of AGRD Part 5B)

a) All open channels and swales must be designed to a shape that reduces the risk of erosion and scour (for example, trapezoidal or similar alternative natural shape).

b) New open channels must be appropriately integrated with the surrounding ecological, visual and physical environments.

c) Swales and open channels must include vegetation to assist in reducing flow velocities, erosion and the biological uptake of soluble pollutants, unless agreed otherwise with the Principal.

d) Scour protection must be natural rock, rock mattresses, gabions or other product approved by the Principal.

e) If dispersive soils (soils having Emerson class 1 or 2 in accordance with AS1289.3.8.1 Methods of testing soils for engineering purposes, Method 3.8.1: Soil classification tests - Dispersion - Determination of Emerson class number of a soil) are encountered additional channel erosion control measures must be provided including:

   i) a minimum 200 mm of non-dispersive topsoil underneath proposed vegetation; or

   ii) other erosion control measures approved by the Principal's Geotechnical Group as part of a relevant Design Documentation submission.

f) Treatments of open drains and channels (including vegetation) must be accurately documented to ensure the channel design cross-section is achieved.

g) A swale and bund arrangement may be used to reduce the footprint of the open channel, where there is insufficient space in the road reserve to convey the design flow rates.

h) The Contractor must provide the Principal's Stormwater Group with the level of service provided by the proposed open channel as part of the relevant Design Documentation submission.

i) Erosion control for inaccessible open channels and swales is to be designed for a 1% AEP storm event or as approved with the Principal.

14.2 Rare or extreme events

a) For the flood resilience flows defined in Table RD-DK-D1-8-2, where the capacity of the open drain, swale or channel may be exceeded the Contractor must:

   i) ensure channel overflows do not inundate priority A or B floor levels for design events as specified in table 6.3 of AGRD Part 5 Drainage - General and Hydrology Considerations; and

   ii) mitigate the risk of resulting damage to the roadway.

b) The Contractor must provide the Principal's Stormwater Group with the design event contained within open channel and the resulting impact to the adjacent land use and roadway from flood resilience flows as part of the relevant Design Documentation submission.

14.3 Normal grassed channels and reinforced grassed channels (sections 2.8.1 and 2.8.2 of AGRD Part 5B)

a) The design of normal grassed and reinforced grass vegetated swales and channels must be integrated with the landscape design and planting schedule.

b) Grassed swales must incorporate erosion mitigation measures (for example, straw bales / silt fencing) to reduce the risk of serious erosion prior to the establishment of the vegetation.

14.4 Channels lined with hard facings (section 2.9 of AGRD Part 5B)

a) Concrete lining (including concrete impregnated fabric) must not be used unless agreed by the Principal's Stormwater Group as a Design Departure.

b) The maximum channel / swale side slopes for hard facings (rip rap or rock mattresses) must be 1:3 (desirable) or 1:2 (maximum).

15 Culverts (section 3 of AGRD Part 5B)

15.1 Structural requirements (section 3.6 of AGRD Part 5B)

Culvert materials must be in accordance with ST-SD-D1 “Design of Structures”.

15.2 Cover (section 3.6.4 of AGRD Part 5B)

Culvert obverts must not be designed higher than the subgrade level (i.e. intruding into the pavement layers) without prior approval from Principal’s Pavements Group as a Design Departure.

15.3 Blockage of culverts (section 3.11 of AGRD Part 5B)

Information on calculation of blockage of culverts is detailed in section 5.10.

15.4 Consideration of large or extreme events (section 3.12 of AGRD Part 5B)

15.4.1 Background

a) Culvert crossings are provided to convey a specific flood immunity. In events greater than the design flood immunity flow, the road may be damaged through erosion when flows overtop the roadway. Overtopping does not always occur at the culvert crossing and multiple overflow points along a roadway may occur.

b) To manage the risk of extreme flood events and the changing climate (due to climate change) the Principal’s approach is to design roadways for flood resilience as detailed in section 8.3.

15.4.2 Assessment and management of extreme events

a) The Contractor must assess each culvert crossing on an individual basis to determine:

   i) the potential for damage to the roadway for flood resilience flows defined in Table RD-DK-D1-8-2 if the culvert capacity is exceeded;

   ii) the consequence and potential impacts from damage to the roadway (for example, economic impacts, traffic disruption and alternative traffic routes, cost of repair versus cost of erosion control measures); and

   iii) erosion control measures (and cost) to mitigate the risk of potential damage.

b) The assessment of each culvert’s performance in flood resilience flows defined in Table RD-DK-D1-8-2 and risk of damage to the roadway must be included in the Design Report.

c) Erosion control measures to manage flood resilience flows defined in Table RD-DK-D1-8-2 at culvert crossings must be provided unless agreed as a Design Departure with the Principal.

d) The Contractor must submit its approach and erosion control measures to the Principal prior to the completion of Preliminary Design which will constitute a **Witness Point**.

15.5 Culvert outlet protection (section 3.13 of AGRD Part 5B)

Figure 3.17 in section 3.13 of AGRD Part 5B Drainage - Open Channels, Culverts and Floodway Crossings is to be used for determining minimum rock size and length of rock protection for box culverts. The “X” axis of figure 3.17 is to be read as ’Pipe diameter or culvert cell height (mm)’.

15.6 Culvert end treatments - traversable endwalls (section 3.14.3 of AGRD Part 5B)

a) Driveable endwalls (headwalls) are normally used face on to traffic (parallel to traffic) typically under driveways and side roads to manage the risk of the headwall becoming a hazard for head on collisions.

b) Driveable endwalls are not required where protected by a roadside barrier.

c) For all road cross culverts, headwalls must all be located outside the hazard zone, where practical.

d) Large culverts greater than 600 mm in diameter or span are not suitable for drivable endwall treatments and must be assessed as a roadside hazard and included in the Network Roadside Risk Intervention Threshold (NRRIT) assessment in accordance with RD-GM-D1 “Road Design”.

16 Floodways (section 4 of AGRD Part 5B)

16.1 Design considerations - Geometric (section 4.2 of AGRD Part 5B)

a) Floodways must be designed, where possible, to cross at right angles in straight sections of the watercourse, with one-way cross fall in the direction of flow, (generally 1-2%) but this may vary with the bed slope of the watercourse.

b) The road longitudinal profile should follow the bed of the watercourse as closely as possible while meeting sight distance requirements. This will reduce the likelihood of eroding the floodway.

16.2 Flood damage (section 4.5 of AGRD Part 5B)

a) Previous floodway structures constructed by the Department in the semi-arid areas of South Australia have adopted a cement treated pavement (nominal 400 mm) with spray seal and concrete cut-off walls to reduce the risk of undermining the pavement.

b) The following considerations apply to the design of floodways:

i) floodway road crossings must comply with the Department Standard Drawing S-4002, sheet 25 or as approved by the Department’s Stormwater Group;

ii) where there is a likelihood of erosion and damage to floodway, cut-off walls should extend across the main channel (where the water depth and velocity will be higher);

iii) cut-off wall depths can be reduced where the likelihood of erosion is low to moderate, and the geometry of the floodway is such that the road pavement is at or close to the level of the watercourse invert;

iv) rock rip-rap can also be used on road batters in conjunction with concrete cutoff walls; and

v) pavement treatment (for example, cement treated) should extend to the apparent width of the floodplain.

17 Pump system requirements

17.1 General

Pump systems may be used when a gravity stormwater system is not physically possible, subject to the approval of the Principal’s Stormwater Group as a Design Departure.

17.2 Pump systems

a) The catchment area contributing to the pump system is to be minimised to reduce the volume, storage, and peak flow rate to be pumped.

b) Pump systems must be supplied complete with pumps, internal pipe work, fixtures, electrical fitting, electrical and valves, to comply with the Reference Documents.

c) For ease of maintenance services and spare parts back-up pump systems (pumps and controls) must be compatible with systems used on other Department sites (for example,

Goodwood junction underpass, Gallipoli underpass, Bakewell underpass, Park Terrace Salisbury) as supplied and maintained by Xylem, unless approved otherwise by the Principal as a Design Departure.

17.3 Pump system design

a) The pump system design must be in accordance with the Reference Documents and the manufacturers' requirements and consider various pump system arrangements to optimise performance whilst also reducing capital and operating costs or maintenance issues.

b) The pump system design must comply with the Urban Drainage Design Manual (HEC-22), U.S. Department of Transportation Federal Highway Administration or other guideline agreed by the Principal's Stormwater Group as a Design Departure.

17.4 Pump system pipework

a) Pump system pipework must suit the pump outlets with a nominal Design Life of 50 years.

b) Pump system pipework must include check and butterfly valves to allow separate disconnection and removal of the pumps, with a single outlet connected to the stormwater rising main adjacent to the sump.

17.5 Underground pump and storage chambers

a) Pump and storage chambers must be designed as concrete structures, in accordance with AS 3735 Concrete structures for retaining liquids, unless approved otherwise by the Principal's Structures Group as a Design Departure.

b) The design of pump and storage chambers must:

i) be watertight (water excluding / retaining);

ii) have a Design Life of 100 years;

iii) enable efficient maintenance and the removal of debris by vacuum truck (at one location) through the use of internal baffles or funnels; and

iv) be approved by the Principal's Structures Group and meet the structural requirements of the Contract Documents as part of the relevant Design Documentation submission.

17.6 Pump control system and cabinet

a) The pump control system must be integrated in the STREAMS platform in accordance with the requirements of RD-ITS-D1 "Design of Intelligent Transport Systems (ITS)".

b) The pump control system must include a key lockable IP66 rated wall mounted vandal proof pump control cabinet which must include:

i) the automatic controller, soft starters, overloads and any other necessary equipment;

ii) alarms, remote operation and telemetry equipment;

iii) pump run indicators, hour run meters and fault indicators for all equipment;

iv) SAPN metering and residual current device dual outlet general power outlet;

v) the SAPN meters and the 2 electrical supplies must be housed in a segregated section of the control cabinet and must be accessible with a key which will not open the main cabinet;

vi) the main cabinet key must not open the segregated section of the cabinet;

vii) a master key must be provided to open both locks referred to in sections 17.6b)v) and 17.6b)vi); and

viii) an emergency by-pass system in the event of controller failure and manual pump switches.

c) Pump controllers must provide:

i) alternative start / stop on dual stormwater and sump pump facilities;

ii) pump supervision controls including running time, leakage and temperature alarms;

iii) reporting functionality to laptop computers as well as remote monitoring;

iv) any associated software needed to provide controls, including training for the Principal's operators;

v) level sensors / float controls;

vi) simple push button and LED alarm controls in the cabinet; and

vii) a Modbus remote terminal unit communications interface to allow remote monitoring and control via STREAMS.

17.7 Redundancy and power supply

a) Pump systems must include the following redundancy provisions:

i) dual pumps with one pump able to convey 5% AEP flows, in the event of failure of the other pump;

ii) power supplied from 2 independent 11 kV circuits with auto-change over switch;

iii) low voltage reticulation switching automatically on failure of either grid within the main switch board cabinet controlling the pumps;

iv) a generator socket on the main board for use in the case of a total failure of the main reticulation system; and

v) over-voltage protection.

b) The Contractor must provide load information (as required by SAPN) to enable an assessment of the proposed connecting 11 kV circuits to the pumping systems (based on considerations including spare capacity and network extension costs).

c) Both pumps must be designed to operate with large inflows and be fitted with flushing valves to remove any refuse during the pumping cycle.

d) The dual pumps must alternate after each operation and be fitted with run time meters.

17.8 Fault monitoring

a) Pumps must be provided with a fault monitoring control unit which must be integrated into the Principal's Traffic Management Centre to allow for fault reporting and operational interrogation.

b) The fault monitoring control unit must be compatible with the existing fault reporting system and must be able to be dialled into for any status interrogation and integrated to STREAMS via Modbus remote terminal unit.

c) Faults to be monitored, at a minimum, must include:

i) high level alarm;

ii) brown-out alarm;

iii) pump alarm (for both pumps 1 and 2);

iv) communication alarm;

v) remote (auto) / local (manual) control selection alarm;

vi) hydrocarbon alarm; and

vii) any other alarm that would be beneficial with the new system.

17.9 Access and maintenance

a) The pump and storage chambers must enable safe access and egress by maintenance personnel in accordance with the Reference Documents.

b) The pump, pump and storage chambers must be designed to enable regular maintenance without the need for personnel to enter a confined space.

c) Safe and efficient access for maintenance personnel to the pumps, controllers and storage chamber(s) must be provided, which must:

i) be at-grade via a lockable access pit lid;

ii) be outside of all traffic lanes or any rail corridors;

iii) enable debris removal via a vacuum truck;

iv) enable raising of the pumps for maintenance at ground level;

v) allow for continued operation of adjacent travel lanes, (at a reduced speed) during regular maintenance of the pump system; and

vi) include an area adjacent to the access pit lids for access and operation of maintenance equipment (for example, vacuum trucks).

17.10 System commissioning

All pumps and associated equipment must be commissioned with the Principal and Department and include training of the Department's operators to ensure its successful operation.

17.11 O&M Manual

a) Details of all road drainage systems operations must be compiled and submitted as part of the O&M Manual.

b) The O&M Manual must include as-built drawings depicting the precise location of all system components.

17.12 Warranty

A warranty must be provided to the benefit of the Principal for all materials and construction for a period of 2 years from the Date of Completion.

18 Stormwater discharge from external development sites

18.1 Connections to existing drains within Department roads

If the Contractor installs a stormwater connection from an external development site (for example, land development subdivision) to a council or Department maintained drain within the Department's maintained road pavement, the following requirements must be complied with:

a) the design must not reduce the existing road drainage standard for the site location;

b) a double side entry pit, for maintenance purposes, is to be constructed at the kerb and gutter on the new pipe connection to the council or Department drain;

c) where the development site levels are lower than gutter level, a back flow prevention device must be included in the development site stormwater system (which must not be in the Department's stormwater pit) to eliminate any potential site flooding in the event of a surcharge in the council or Department stormwater system; and

d) a connection is not permitted to a side entry pit located remote from the development site such that it would require the laying of a long skewed pipe across or along the footpath.

18.2 Surface discharge to Department roads

a) The post development peak flow rate from an external site must remain unchanged from the pre-development flow rate, for the relevant Department road drainage or protection standard.

b) Pipe or rectangular hollow section discharge to a kerb must be limited to a 1% AEP storm event peak flow rate of 20 L/s. The peak flow velocity at the discharge point to the kerb must be less than or equal to 1.5 m/s.

c) The manner of surface discharge must be similar to pre-development conditions, in order to avoid concentration of the flow (for example, if 2 allotments are combined to form one development, discharge must not be to one point).

d) No stormwater discharge is to be pumped directly to the kerb and gutter. Stormwater from adjacent properties must be pumped to a pit inside the property and gravity fed to the kerb or roadside swale.

18.3 External developments impact on overland flow paths

a) The potential impact from changes in adjacent land use from external sites (for example, development sites and developer projects) must be completed where there is a risk that the project modifies overland flow paths or increases peak flow rates that could increase the likelihood of flooding the Department's roads.

b) A basic assessment of peak flows from the upstream catchment area, likely flow capacity of the underground stormwater system and overland flow paths must be undertaken to assess the likelihood of increased flooding surrounding the Project.

c) Where the initial assessment identifies a risk of increased flooding, a more detailed 2D hydraulic analysis to simulate existing and proposed flood levels with afflux maps must be generated, and the Contractor must assess this risk and develop mitigation strategies to reduce the likelihood of flooding surrounding properties.

d) For the avoidance of doubt, differences of ±20 mm between existing and proposed flood levels are shown as no change in the afflux maps. Flood levels in excess of 20 mm must be mitigated unless otherwise agreed with the Principal's Stormwater Group and council (as applicable) as a Design Departure.

19 Hold and Witness Points

a) Table RD-DK-D1 19-1details the review period or notification period, and type (documentation or construction quality) for each Hold Point referred to in this Master Specification Part.

b) Table RD-DK-D1 19-2 details the review period or notification period, and type (documentation or construction quality) for each Witness Point referred to in this Master Specification Part.

Table RD-DK-D1 19-1 Hold Points

Section reference	Hold Point	Documentation or construction quality	Review period or notification period
5.4g)	Acceptance of the water quality risk assessment outcomes	Documentation	10 Business Days review
5.8.4g)	Acceptance of not achieving the water quality improvements targets (in-line with the water quality risk assessment outcome)	Documentation	10 Business Days review
7.2d)	Evidence of approval of proposed ongoing maintenance requirements	Documentation	10 Business Days review
7.3e)	Acceptance of retaining existing stormwater infrastructure assets with less than 50% of residual Design Life	Documentation	10 Business Days review
8.3.1d)	Confirmation of the proposed flood immunity of roads and paths	Documentation	10 Business Days review

Section reference	Hold Point	Documentation or construction quality	Review period or notification period
8.4.5c)	Confirmation of the proposed flood immunity of adjacent land use	Documentation	10 Business Days review
8.6.1c)	Submission of the recommended hydrological flows	Documentation	5 Business Days review

Table RD-DK-D1 19-2 Witness Points

Section reference	Witness Point	Documentation or construction quality	Review period or notification period
5.10j)	Submission of the blockage factors and approach	Documentation	10 Business Days review
6.2c)	Submission of the assessment for time of submergence on National Highways	Documentation	10 Business Days review
7.1b)	Sketch detailing the stormwater asset ownership	Documentation	5 Business Days review
8.6.4c)	Submission of hydrological estimates in arid and semi-arid regions	Documentation	5 Business Days review
15.4.2d)	Submission of recommendations for floodway erosion control measures	Documentation	10 Business Days review

20 Appendix 1: Location adjustment factor (step 4 of Department Rational Method)